Coastal Processes Related to Desalination Plants In Coastal Waters

by

Scott A. Jenkins, PhD
Joseph Wasyl

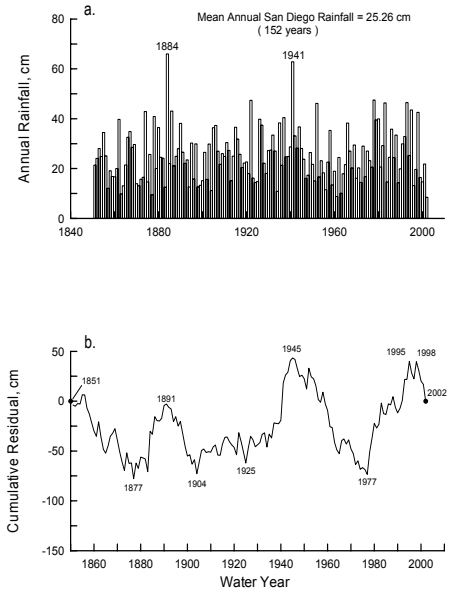
Scripps Institution of Oceanography

Need

1) California subject to multi-decadal wet-dry cycles

2) California due for multi-decadal dry period

3) Global warming will progressively diminish California's snow pack



Multi-Decadal Wet-Dry Cycles

03.K3-1

Coastal Processes Issues

Receiving Water

1) Dispersion & dilution of concentrated seawater by-products

2) Effect of concentrated seawater by-products on dilution of combined constituent discharges (waste heat, treated sewage effluent, etc.)

Source Water

1) Source water quality

2) Potential for re-circulation of concentrated sea water by-products

Modeling Scenarios

1) Seven controlling variables

2) Worst combination of controlling variables results in low ambient mixing and high source loading

   * worst day
   * worst month

3) Average combination of controlling variables

   * average day
   * average month

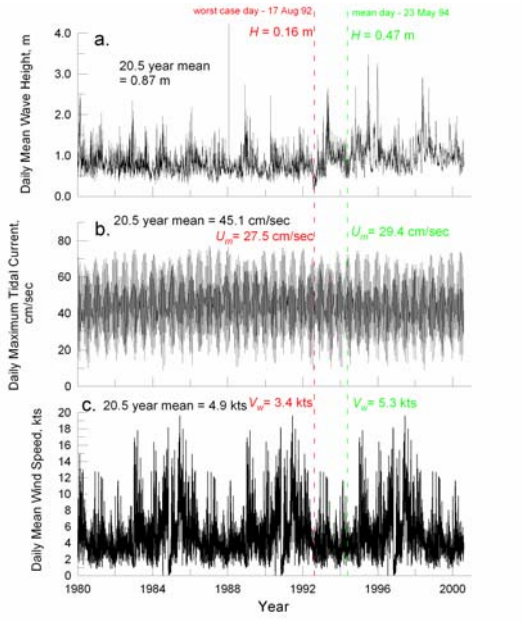


Figure 3.15. Period of record of forcing functions in the nearfield of Encina Power Plant, 1980-2000.5: a) daily mean wave height, b) daily maximum tidal current velocity, and c) daily mean wind.

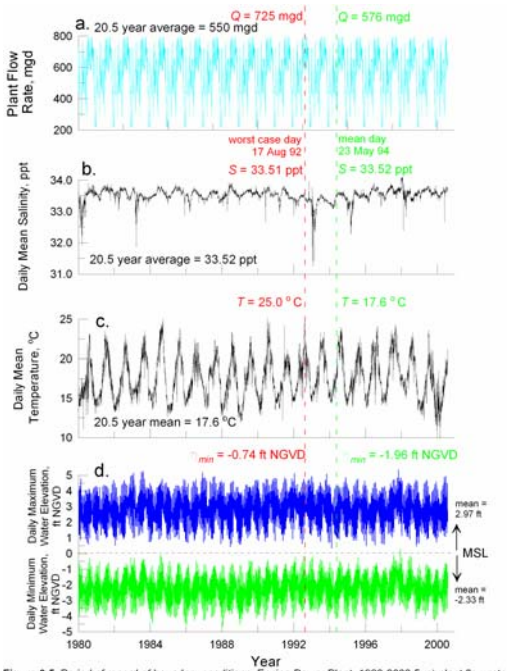


Figure 3.5. Period of record of boundary conditions, Encina Power Plant, 1980-2000.5: a) plant flow rate b) daily mean salinity, c) daily mean temperature, and d) daily high and low water elevations.

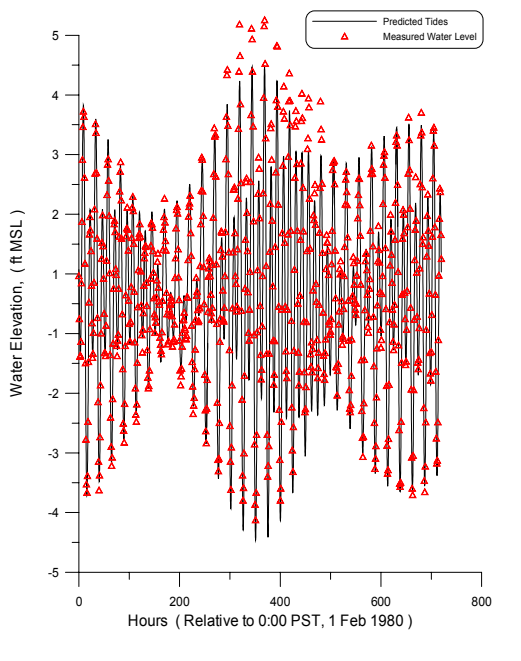
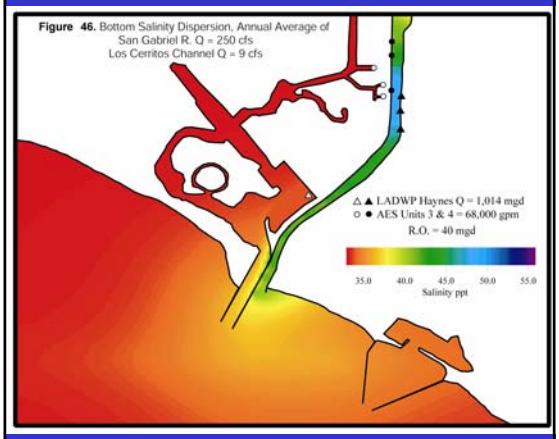


Figure 6. Predicted Tides vs measured water levels at Los Angeles, CA NOAA Tide Gage #941-0660, February 1980.

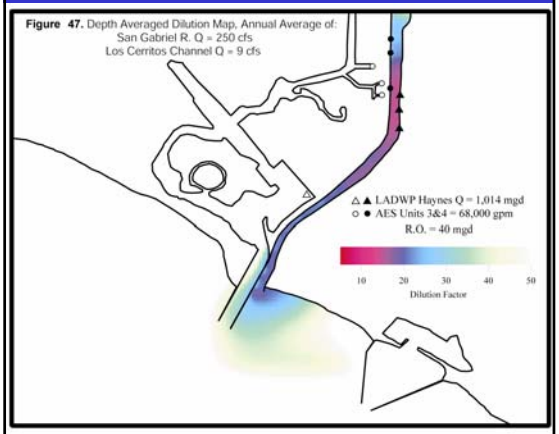
Leading Order Boundary Conditions

1) Receiving Waters
   - Confined Water Body
   - Open Coast / Offshore Discharge
   - Shoreline Discharge

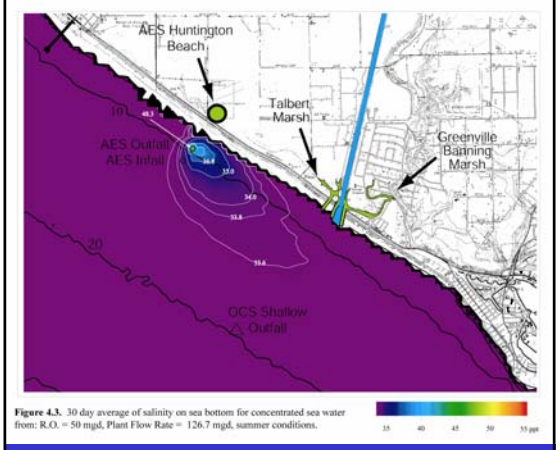
2) External Sources
   - Rivers
   - Outfalls
   - Non-Point Sources



Confined Water Body



Confined Water Body



Exposed Open Coast Offshore Discharge

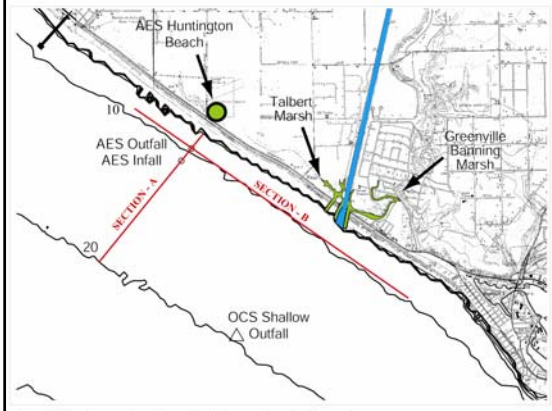


Figure 1. Location map for salinity profiles of source water and dilution modeling.

Exposed Open Coast Offshore Discharge

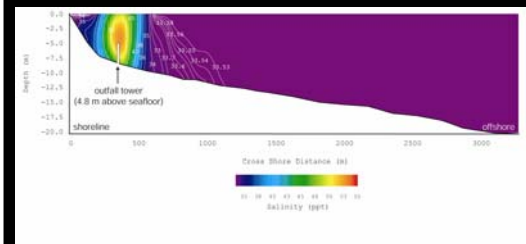


Figure 2. Cross shore salinity profile through the AES Huntington outfall along Section-A (see Figure 1). 30-day average of salinity for concentrated sea water discharge using: R.O. = 50 mgd, Power Plant Flow Rate = 126.7 mgd, summer conditions. (Profile corresponds to results in Figures 4.1 - 4.3 of Jenkins and Wasyl, 2001, Part I.)

Exposed Open Coast Offshore Discharge

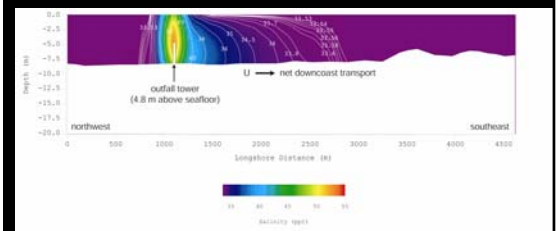


Figure 3. Longshore salinity profile through the AES Huntington outfall along Section-B (see Figure 1). 30-day average of salinity for concentrated sea water discharge using: R.O. = 50 mgd, Power Plant Flow Rate = 126.7 mgd, summer conditions. (Profile corresponds to results in Figures 4.1 - 4.3 of Jenkins and Wasyl, 2001, Part I.)

Exposed Open Coast Offshore Discharge

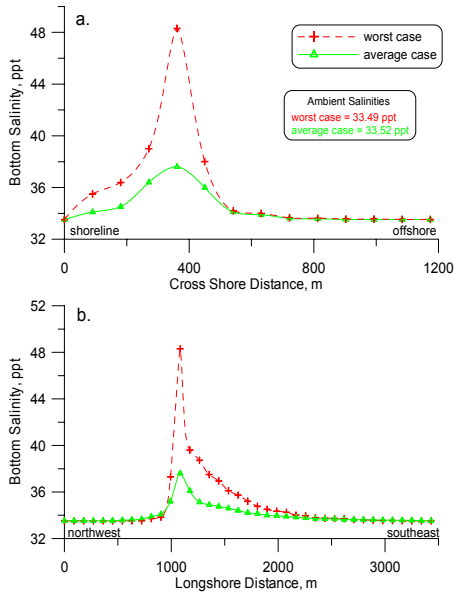


Figure 5. Thirty day average of bottom salinity for worst and average case months along: a) crossshore profile (Section A), b) longshore profile (Section B).

Exposed Open Coast Offshore Discharge

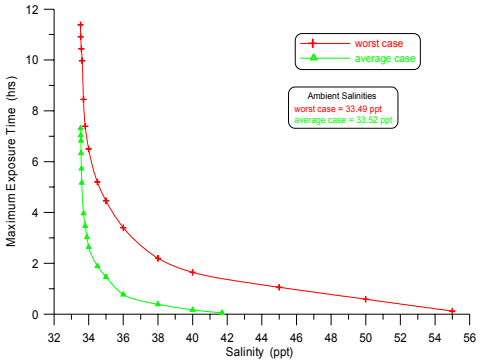


Figure 4. Maximum exposure time of a drifting organism passing through the discharge plume of concentrated seawater from the AES Huntington Beach outfall for worst case conditions (red, plant flow rate = 126.7 mgd) and average case conditions (green, plant flow rate = 253.4 mgd).

Exposed Open Coast Offshore Discharge

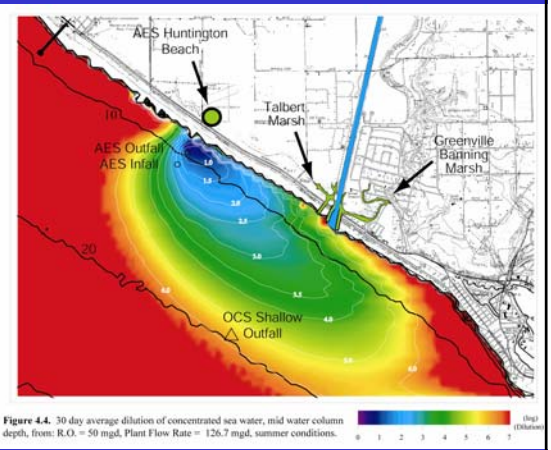


Figure 4.4. 30 day average dilution of concentrated sea water, mid water column depth, from: R.O. = 50 mgd, Plant Flow Rate = 126.7 mgd, summer conditions.

Exposed Open Coast Offshore Discharge

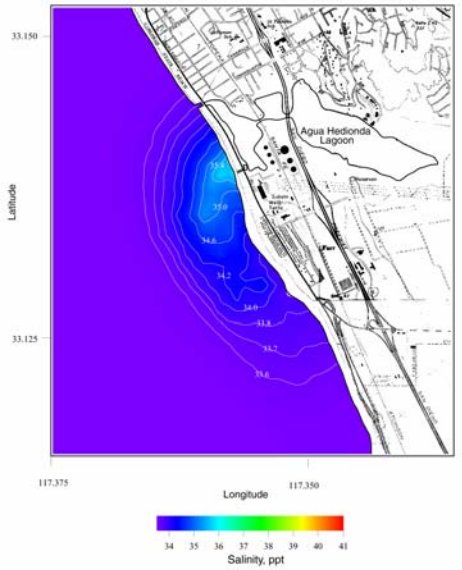


Figure 1. Daily average of the bottom salinity of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 725.8 mgd, combined discharge = 675.8 mgd, ambient ocean salinity = 33.51 ppt, worst case day (17 Aug 1992).

Shoreline Discharge

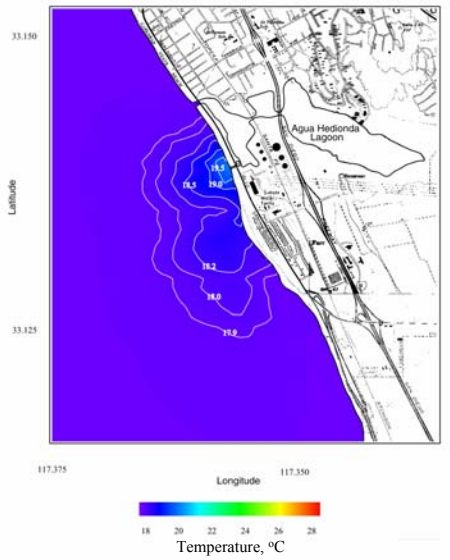


Figure 4.45. 30 day average of the bottom temperature of concentrated seawater for R.O. = 50 mgd, plant inflow rate = 527 mgd, combined discharge = 477 mgd, ambient ocean temperature = 17.81 °C, 30 day period (May - June 1994).

Combined Constituent (Heat)

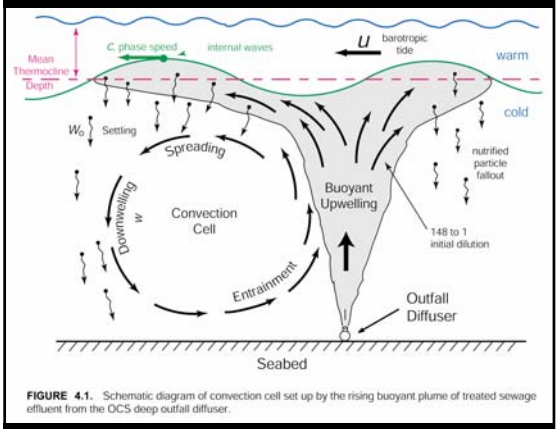


FIGURE 4.1. Schematic diagram of convection cell set up by the rising buoyant plume of treated sewage effluent from the OCS deep outfall diffuser.

Combined Constituent (Treated Sewage Effluent)

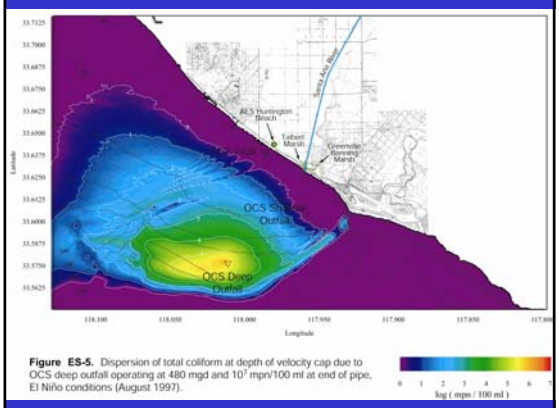


Figure ES-5. Dispersion of total coliform at depth of velocity cap due to OCS deep outfall operating at 480 mgd and 10^7 mpn/100 ml at end of pipe, El Niño conditions (August 1997).

log (mpn / 100 ml)

Source Water Quality Waste Field from Treated Sewage Outfall

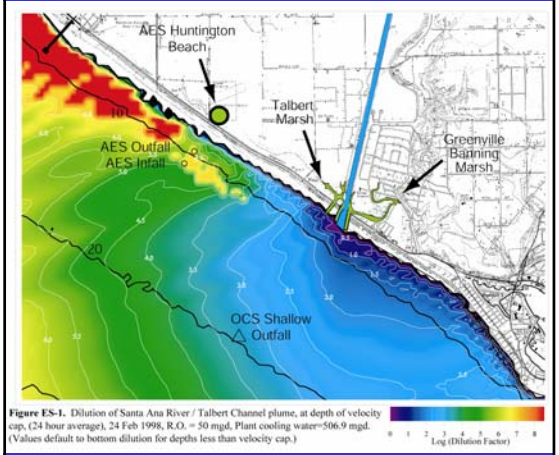


Figure ES-1. Dilution of Santa Ana River / Talbert Channel plume, at depth of velocity cap, (24 hour average), 24 Feb 1998, R.O. = 50 mgd, Plant cooling water=506.9 mgd. (Values default to bottom dilution for depths less than velocity cap.)

Log (Dilution Factor)

Source Water Quality River Discharge

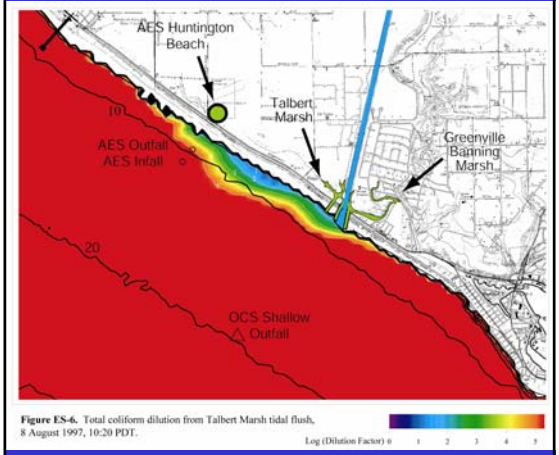


Figure ES-6. Total coliform dilution from Talbert Marsh tidal flush, 8 August 1997, 10:20 PDT.

Log (Dilution Factor)

Source Water Quality Non-Point Source

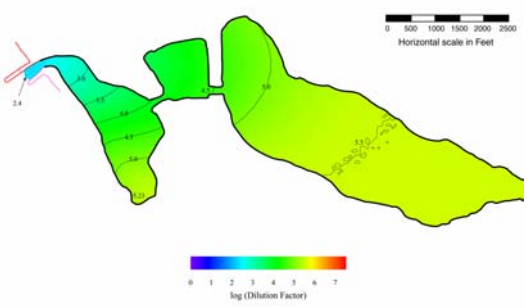


Figure 4.50. Lagoon bottom dilution of concentrated sea water for R.O. = 50 mgd, plant inflow rate = 725.8 mgd, combined discharge = 675.8 mgd, ambient ocean salinity = 33.51 ppt, worst case day (17 Aug 1992).

Re-Circulation of Desalination By-Products

Design Objectives:

1) Saline impacts within tolerance of marine biology
2) Negligible re-circulation of desalination by-products
3) No increase in footprint of combined constituent discharges (ie. heat)
4) Source water drawn from location and depth where ambient contaminants are within removal capabilities of R.O. membranes
5) No increase in footprint of existing contaminant fields